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A Review on Design of Fixtures

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ABSTRACT - In machining fixtures, minimizing workpiece deformation due to clamping and cutting forces is essential to maintain the machining accuracy. The various methodology used for clamping operation used in different application by various authors are reviewed in this paper. Fixture is required in various industries according to their application. This can be achieved by selecting the optimal location of fixturing elements such as locators and clamps. The fixture set up for component is done manually. For that more cycle time required for loading and unloading the material. So, there is need to develop system which can help in improving productivity and time. Fixtures reduce operation time and increases productivity and high quality of operation is possible.

keywords: fixture, accuracy, clamping, productivity.

I. INTRODUCTION

The fixture is a special tool for holding a work piece in proper position during manufacturing operation. For supporting and clamping the work piece, device is provided. Frequent checking, positioning, individual marking and non-uniform quality in manufacturing process is eliminated by fixture. This increase productivity and reduce operation time. Fixture is widely used in the industry practical production because of feature and advantages.

To locate and immobilize workpieces for machining, inspection, assembly and other operations fixtures are used. A fixture consists of a set of locators and clamps. Locators are used to determine the position and orientation of a workpiece, whereas clamps exert clamping forces so that the workpiece is pressed firmly against locators. Clamping has to be appropriately planned at the stage of machining fixture design. The design of a fixture is a highly complex and intuitive process, which require knowledge. Fixture design plays an important role at the setup planning phase. Proper fixture design is crucial for developing product quality in different terms of accuracy, surface finish and precision of the machined parts In existing design the fixture set up is done manually, so the aim of this project is to replace with hydraulic fixture to save time for loading and unloading of component. Hydraulic fixture provides the manufacturer for flexibility in holding forces and to optimize design for machine operation as well as process functionability.

Steps of fixture design

Successful fixture designs begin with a logical and systematic plan. With a complete analysis of the fixture's functional requirements, very few design problems occur. When they do, chances are some design requirements were forgotten or underestimated. The workpiece, processing, tooling and available machine tools may affect the extent of planning needed. Preliminary analysis may take from a few hours up to several days for more complicated fixture designs. Fixture design is a five-step problem-solving process. The following is a detailed analysis of each step.

Step 1: Define Requirements

To initiate the fixture-design process, clearly state the problem to be solved or needs to be met. State these requirements as broadly as possible, but specifically enough to define the scope of the design project. The designer should ask some basic questions: Is the new tooling required for first-time production or to improve existing production?

Step 2: Gather/Analyze Information

Collect all relevant data and assemble it for evaluation. The main sources of information are the part print, process sheets, and machine specifications. Make sure that part documents and records are current. For example, verify that the shop print is the current revision, and the processing information is up-to-date. Check with the design department for pending part revisions. An important part of the evaluation process is note taking. Complete, accurate notes allow designers to record important information. With these notes, they should be able to fill in all items on the "Checklist for Design Considerations." All ideas, thoughts, observations, and any other data about the part or fixture are then available for later reference. It is always better to have too many ideas about a particular design than too few. Four categories of design considerations need to be taken into account at this time: workpiece specifications, operation variables, availability of equipment, and personnel. These categories, while separately covered here, are actually

interdependent. Each is an integral part of the evaluation phase and must be thoroughly thought out before beginning the fixture design.

Step 3: Develop Several Options

This phase of the fixture-design process requires the most creativity. A typical workpiece can be located and clamped several different ways. The natural tendency is to think of one solution, then develop and refine it while blocking out other, perhaps better solutions. A designer should brainstorm for several good tooling alternatives, not just choose one path right away. During this phase, the designer's goal should be adding options, not discarding them. In the interest of economy, alternative designs should be developed only far enough to make sure they are feasible and to do a cost estimate. The designer usually starts with at least three options: permanent, modular, and general-purpose workholding. Each of these options has many clamping and locating options of its own. The more standard locating and clamping devices that a designer is familiar with, the more creative he can be. Areas for locating a part include flat exterior surfaces (machined and unmachined), cylindrical and curved exterior surfaces. The exact procedure used to construct the preliminary design sketches is not as important as the items sketched. Generally, the preliminary sketch should start should start with the part to be fixtured. The required locating and supporting elements, including a base, should be the next items added. Then sketch the clamping devices. Finally, add the machine tool and cutting tools. Sketching these items together helps identify any problem areas in the design of the complete fixture.

Step 4: Choose the Best Option

The total cost to manufacture a part is the sum of per-piece run cost, setup cost, and tooling cost. Expressed as a formula:

$$\text{Cost per Part} = \text{Run Cost} + \frac{\text{Setup Cost}}{\text{Lot Size}} + \frac{\text{Tooling Cost}}{\text{Total Quanity Over Tooling Lifetime}}$$

These variables are described below with sample values from three tooling options: a modular fixture, a permanent fixture, and a hydraulically powered permanent fixture.

Step 5: Implement the Design

The final phase of the fixture-design process consists of turning the chosen design approach into reality. Final details are decided, final drawings are made, and the tooling is built and tested. The following guidelines should be considered during the final-design process to make the fixture less costly while improving its efficiency. These rules are a mix of practical considerations, sound design practices, and common sense [9].

i. Use standard components: The economies of standard parts apply to tooling components as well as to manufactured products. Standard, readily available components include clamps, locators, supports, studs, nuts, pins and a host of other elements. Most designers would never think of having the shop make cap screws, bolts or nuts for a fixture. Likewise, no standard tooling components should be made in-house. The first rule of economic design is: Never build any component you can buy. Commercially available tooling components are manufactured in large quantities for much greater economy. In most cases, the cost of buying a component is less than 20% of the cost of making it.

Labor is usually the greatest cost element in the building of any fixture. Standard tooling components are one way to cut labor costs. Browse through catalogs and magazines to find new products and application ideas to make designs simpler and less expensive.

ii. Use prefinished materials: Prefinished and preformed materials should be used where possible to lower costs and simplify construction. These materials include precision-ground flat stock, drill rod, structural sections, cast tooling sections, precast tooling bodies, tooling plates, and other standard preformed materials. Including these materials in a design both reduces the design time and lowers the labor cost.

iii. Eliminate finishing operations: Finishing operations should never be performed for cosmetic purposes. Making a fixture look better often can double its cost. Here are a few suggestions to keep in mind with regard to finishing operations.

iv. Keep tolerances as liberal as possible: The most cost-effective tooling tolerance for a locator is approximately 30% to 50% of the workpiece's tolerance. Tighter tolerances normally add extra cost to the tooling with little benefit to the process. Where necessary, tighter tolerances can be used, but tighter tolerances do not necessarily result in a better fixture, only a more expensive one.

II .IMPORTANT CONSIDERATIONS WHILE DESIGNING JIGS AND FIXTURES.

Designing of jigs and fixtures depends upon so many factors. These factors are analyzed to get design inputs for jigs and fixtures. The list of such factors is mentioned below :

a. Study of workpiece and finished component size and geometry.

b. Type and capacity of the machine, its extent of automation.

c. Provision of locating devices in the machine.

d. Available clamping arrangements in the machine.

e. Available indexing devices, their accuracy.

f. Evaluation of variability in the performance results of the machine.

g. Rigidity and of the machine tool under consideration.

h. Study of ejecting devices, safety devices, etc.

i. Required level of the accuracy in the work and quality to be produced.

III. MEANING OF LOCATION

The location refers to the establishment of a desired relationship between the workpiece and the jigs or fixture correctness of location directly influences the accuracy of the finished product. The jigs and fixtures are desired so that all undesirable movements of the workpiece can be restricted. Determination of the locating points and clamping of the workpiece serve to restrict movements of the component in any direction, while setting it in a particular pre-decided position relative to the jig. Before deciding the locating points it is advisable to find out the all possible degrees of freedom of the workpiece. Then some of the degrees of freedom or all of them are restrained by making suitable arrangements. These arrangements are called locators. These are described in details below[11]:

1.PRINCIPLES OF LOCATIONS

The principle of location is being discussed here with the help of a most popular example which is available in any of the book covering jigs and fixtures. It is important that one should understand the problem first. Any rectangular body many have three axis along x-axis, y-axis and z-axis. It can more along any of these axes or any of its movement can be released to these three axes. At the same time the body can also rotate about these axes too. So total degree of freedom of the body along which it can move is six. For processing the body it is required to restrain all the degree of freedom (DOF) by arranging suitable locating points and then clamping it in a fixed and required position. The basic principle used to locate the points is desirable below. Six Points Location of a Rectangular Block. It is made to rest on several points on the jig body. Provide a rest to workpiece on three points on the bottom x-y surface. This will stop the movement along z-axis, rotation with respect to x-axis and y-axis. Supporting it on the three points is considered as better support then one point or two points. Rest the workpiece on two points of side surface (x-z), this will fix the movement of workpiece along y-axis and rotation with respect to z-axis. Provide a support at one point of the adjacent surface (y-z) that will fix other remaining free movements. This principle of location of fixing points on the workpiece is also named as 3-2-1 principle of fixture design as numbers of points selected at different faces of the workpiece are 3, 2 and 1 respectively. If the operation to be done on the cylindrical object requires restriction of the above mentioned free movements also than some more locating provisions must also be incorporated in addition to use of the Vee block. Guohua Qin[1] focuses on the fixture clamping sequence. It consists of two parts:

a. For the first time he evaluated varying contact forces and workpiece position errors in each clamping step by solving a nonlinear mathematical programming problem. This is done by minimizing the total complementary energy of the workpiece-fixture system. The prediction proves to be rigorous and reasonable after comparing with experimental data and referenced results.

b. The optimal clamping sequence is identified based on the deflections of the workpiece and minimum position error. Finally, To predict the contact forces and to optimize the clamping sequence three examples are discussed.

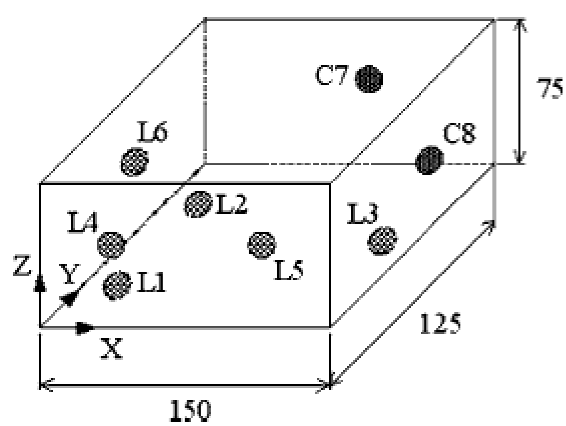

Fig. 1 Scheme of 3-2-1 fixture setup [1].

First mathematical modeling for clamping sequence is done then he determined the contact forces in clamping sequence as shown in fig. 1. After that he optimized of clamping sequence for higher stiffness workpiece and low stiffness workpiece. He found that with the use of optimal clamping sequence, good agreements are achieved between predicted results and experimental data and the workpiece machining quality can be improved .

For a fixture designer, the major portion of design time is spent deciding how to locate the work piece in the fixture. You know that any free body has a total of twelve degrees of freedom as below:

6 translational degrees of freedom**: +X, -X, +Y, -Y, +Z, -Z**

And 6 rotational degrees of freedom:

- Clockwise around X axis (**CROT-X**)

- Anticlockwise around X axis (**ACROT-X**)

- Clockwise around Y axis (**CROT-Y**)

- Anticlockwise around Y axis (**ACROT-Y**)

- Clockwise around Z axis (**CROT-Z**)

- Anticlockwise around Z axis (**ACROT-Z**)

You must fix all the 12 degrees of freedom except the three transitional degrees of freedom (-X, -Y and -Z) in order to locate the work piece in the fixture. So, 9 degrees of freedom of the work piece need to be fixed. But, how? By using the **3-2-1 method** as shown below in fig. 2 :

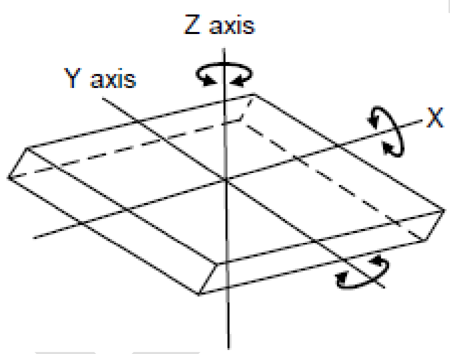

Fig. 2 Available Degree of Freedom of Rectangular Block[11]

Now, rest the work piece at **two** points of side surface (XZ), and you will be able to fix the **+Y** and **ACROT-Z** degrees of freedom. Now, rest the work piece at **one** point of the adjacent surface (YZ), and you will be able to fix the **+X** and **CROT-Z** degrees of freedom. So, you can successfully fixate **9** required degrees of freedom by using the 3-2-1 principle of fixture design.

Nicholas Amaral [6] develop a method for modeling workpiece boundary conditions and applied loads during a machining process, optimize support locations, using finite element analysis (FEA) and analyses modular fixture tool contact area deformation. The workpiece boundary conditions are defined by locators and clamps. To constrain using linear spring-gap elements the locators are placed in a 3-2-1 fixture configuration and modeled using all degrees of freedom of the workpiece. To model cutting forces during drilling and milling machining operations, the workpiece is loaded. Fixture design integrity is verified. To develop an algorithm to automatically optimize fixture support and clamp locations. To minimize deformation in workpiece, subsequently increasing machining accuracy ANSYS parametric design language code is used. Unnecessary and uneconomical "trial and error" experimentation on the shop floor is eliminated by implementing

FEA in a computer-aided-fixture-design environment.

2. DIFFERENT METHODS USED FOR LOCATION

There are different methods used for location of a work. The locating arrangement should be decided after studying the type of work, type of operation, degree of accuracy required. Volume of mass production to be done also mattes a lot. Different locating methods are described below.:

Flat Locator

Flat locators are used for location of flat machined surfaces of the component. Three different examples which can be served as a general principle of location are described here for flat locators. These examples are illustrated in Fig. 3

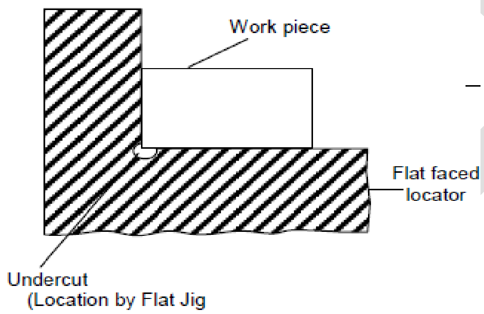

Fig. 3 Flat locator[11]

A flat surface locator can be used as shown in first figure. In this case an undercut is provided at the bottom where two perpendicular surfaces intersect each other. This is made for swarf clearance. The middle figure shows flat headed button type locator. There is no need to made undercut for swarf clearance. It is used for locating components having drilled holes. The cylindrical component to be located is gripped by a cylindrical locator fitted to the jig's body and inserted in the drilled hole of the component.

Jack Pin Locator

Jack pin locator is used for supporting rough workpieces from the button as shown in Fig. 4. Height of the jack pin is adjustable to accommodate the workpieces having variation in their surface texture. So this is a suitable method to accommodate the components which are rough and un-machined.

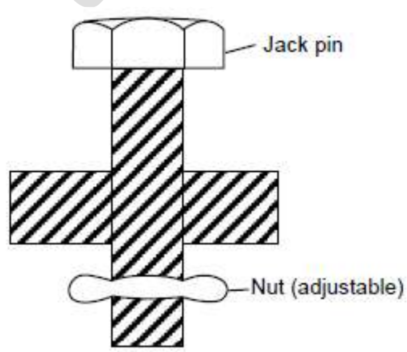

Fig. 4 Jack Pin Locator[11]

Drill Bush Locator

The drill bush locator is used for holding and locating the cylindrical workpieces. The bush has conical opening for locating purpose and it is sometimes screwed on the jigs body for the adjustment of height of the work.

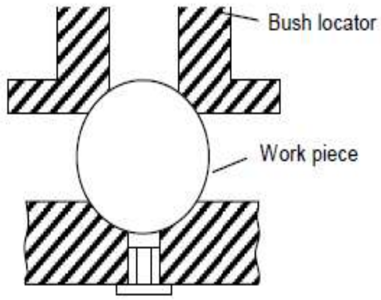

Fig. 5 Drill Bush Locator[11]

Vee Locators

This is quick and effective method of locating the workpiece with desired level of accuracy. This is used for locating the circular and semi-circular type of workpiece. The main part of locating device is Vee shaped block which is normally fixed to the jig. This locator can be of two types fixed Vee locator and adjustable Vee locator. The fixed type locator is normally fixed on the jig and adjustable locator can be moved axially to provide proper grip of Vee band to the workpiece.

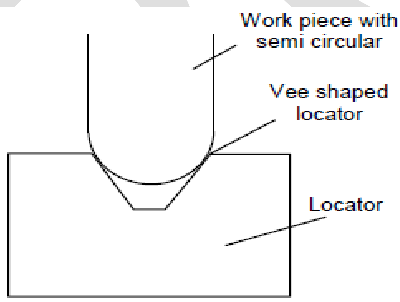

Fig. 6 Vee Locator[11]

Locating error and machining error were studied by systematic method of error identification and calculation, in which. using finite element analysis (FEA). The machining error, the surface error shown in fig. 7 generated from machining operations by Y. Wang [7].

Fig. 7 Surface error sources [7].

A methodology of machined surface error calculation and error decomposition was presented in this paper. The research has focused on (a) surface error including both locating error and machining error, also machining error generated during multi machining operations was analyzed; (b) the sensitivity of individual errors was investigated, and the resultant surface error of locating and machining was evaluated against tolerance; and (c) the method is suitable for both components with complex geometry as well as simple geometry.

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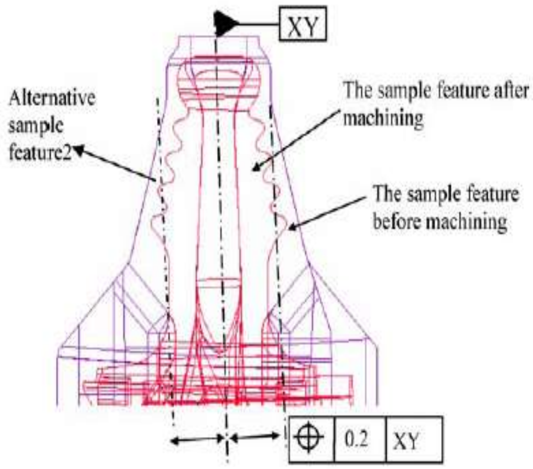

Fig. 8 Tolerance of the sample feature [7]

The surface error analysis of a sample feature of turbine blades was presented to demonstrate the developed procedure and analysis. The result suggested that the component does not satisfy the tolerance requirement due to fixture related errors such as clamping deformation shown in fig. 8, workpiece movement, and workpiece twist. The methods of error reduction were proposed

IV. CLAMPING

To restrain the workpiece completely a clamping device is required in addition to locating device and jigs and fixtures. A clamping device holds the workpiece securely in a jig or fixture against the forces applied over it during on operation. Clamping device should be incorporated into the fixture, proper clamp in a fixture directly influence the accuracy and quality of the work done and production cycle time. Basic requirement of a good clamping device are listed below :

a. It should rigidly hold the workpiece.

b. The workpiece being clamped should not be damaged due to application of clamping pressure by the clamping unit.

c. The clamping pressure should be enough to overcome the operating pressure applied on the workpiece as both pressure act on the workpiece in opposite directions.

d. Clamping device should be capable to be unaffected by the vibrations generated during an operation.

e. It should also be user friendly, like its clamping and releasing should be easy and less time consuming. Its maintenance should also be easy.

f. Clamping pressure should be directed towards the support surfaces or support points to prevent undesired lifting of workpiece from its supports.

g. Clamping faces should be hardened by proper treatments to minimize their wearing out.

h. To handle the workpieces made of fragile material the faces of clamping unit should be equipped with fiber pads to avoid any damage to workpiece.

J. Cecil[5] proposed an innovative clamping design approach is described in the context of fixture design activities. The clamping design approach involves identification of clamping surfaces and clamp points on a given workpiece. This approach can be applied in conjunction with a locator design approach to hold and support the workpiece during machining and to position the workpiece correctly with respect to the cutting tool. Detailed steps are given for automated clamp design. Geometric reasoning techniques are used to determine feasible clamp faces and positions. The required inputs include CAD model specifications, features identified on the finished workpiece, locator points and elements.

1.DIFFERENT TYPES OF CLAMPS

Different variety of clamps used with jigs and fixtures are classified into different categories are discussed here:

Strap Clamp

This is also called edge clamp. This type clamping is done with the help of a lever pressure acting as a strap on the workpiece. Different types of strap clamps are discussed below.

Heel Clamp

Rotation of the clamp in clockwise direction is prevented and it is allowed in anticlockwise direction. For releasing the workpiece the clamping nut is unscrewed. The free movements in anticlockwise direction takes place before un-securing the nut to release the workpiece.

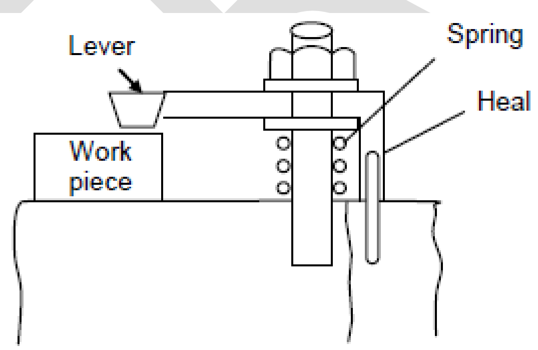

Fig. 9 Heel Clamp[11]

Bridge Clamp

The bridge clamp applies more clamping pressure as compared to heel clamp. The clamping pressure experienced by the workpiece depends on the distances „x‟ and „y‟ marked. To release the workpiece the nut named as clamping nut is unscrewed. The spring lifts the lever to release the workpiece.

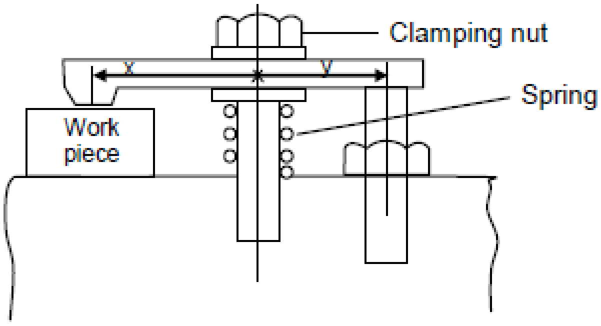

Fig. 10 Bridge Clamp

Edge Clamp or Side Clamp

A side clamp is also known as edge clamp. In this case the surface to be machined is always clamped above the clamping device. This clamping device is recommended for fixed length workpiece. Releasing and clamping of the workpiece can be accomplished by unscrewing and screwing of the clamping nut respectively.

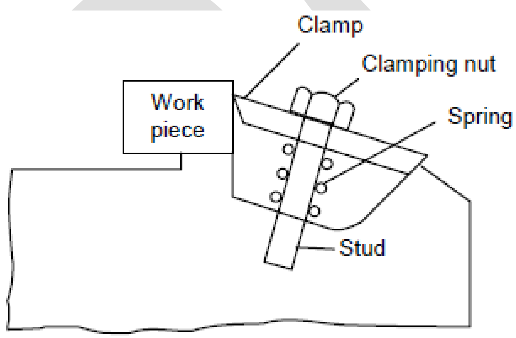

Fig. 11 Edge Clamp or Side Clamp[11]

Screw Clamp

The screw clamp is also known as clamp screw. This clamping apply pressure directly on the side faces of the workpiece.

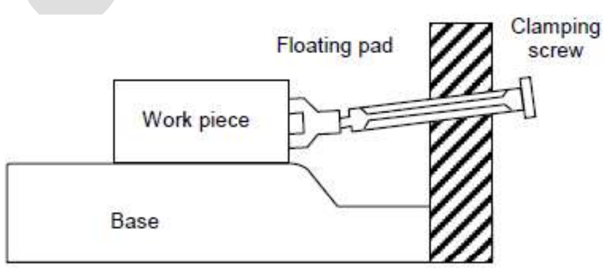

Fig. 12 Screw Clamp[11]

There is a floating pad at their end to serve the following purposes :

a. It prevents displacement of workpiece and slip.

b. It prevents denting of clamping area of workpiece.

c. The available cushion prevents deflection of screw.

In addition to the above there are some disadvantages associated with this method. The clamping pressure largely depends on the workpiece; it varies from one workpiece to other. It is more time consuming and more efforts are required.

Latch Clamp

Latch clamps are used to clamp the workpiece, the clamping system is normally locked with the help of a latch provided. To unload the workpiece the tail end of the latch is pushed that causes the leaf to swung open, so releasing the workpiece. Here time consumed in loading and unloading is very less as no screw is tightened but clamping pressure is not so high as in other clamping devices. Life of this type of clamping device is small.

Equalizing Clamps

Equalizing clamp is recommended to apply equal pressure on the two faces of the work. The pressure applied can be varied by tightened or loosening the screw provided for the purpose.

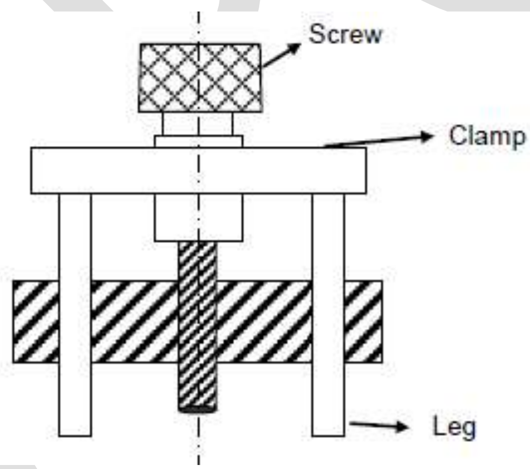

Fig. 13 Equalizing Clamps[11]

Power Driven Clamping

Light duty clamps are used manually because small power is required to operate these clamps. Hand clamping leads to application of variable pressure, operator's fatigue and more time consumed. The power driven clamping over comes the above mentioned problems of hand clamping. Power clamps are operated on the base of hydraulic or pneumatic power. Power clamps are high pressure clamping, these are quick acting, easily controllable, reliable and less time consuming.

V. SOFTWARE FOR FIXTURE DESIGN

NX streamlines the entire tool development process including part design, tool assembly layout, and detailed tooling design and validation. Using NX's advanced functionality, step-by-step guidance and associatively with part designs, you can work with even the most challenging tooling and fixture designs. These are discussed below[10]

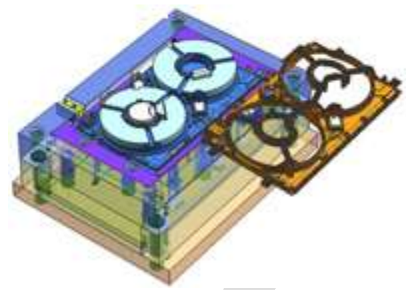

Fig. 14 NX Mold Design[10]

NX Mold Design shown in fig. 14 automates and streamlines the entire mold development process including part design, tool design and motion validation. You can ensure fast response to design changes and high-quality molds.

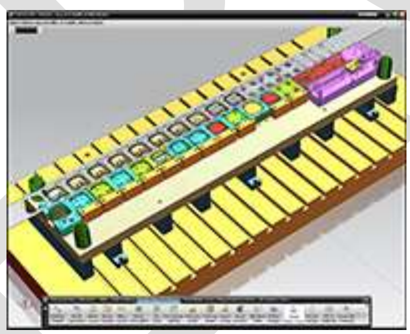

Fig. 15 NX Progressive Die Design[10]

NX guides you through all of the stages required to design a progressive die, automating the most tedious tasks and streamlining the most complex processes which is shown in fig.15. NX Progressive Die Design is a comprehensive solution for both straight break and freeform sheet metal parts. You can design the complete die structure with associatively to the part design at every stage.

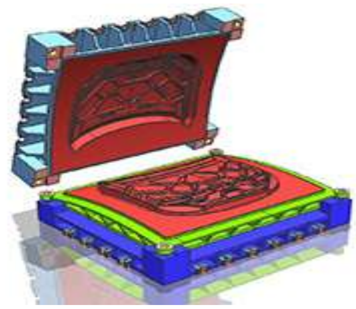

Fig. 16 NX Stamping Die Design[10]

The advanced capabilities in NX for designing automotive stamping dies include formability analysis, die planning, die face design, detailed die structure design and die validation. NX Stamping Die Design guides you in defining the process used to manufacture complex stamped sheet metal parts, producing a representation of the press line and modeling the shape of the sheet metal as it leaves each press.

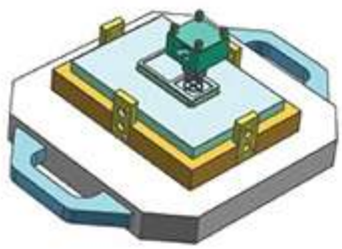

Fig. 17 NX Electrode Design[10]

NX Electrode Design incorporates numerous industry best practices into a step-by-step approach that automates the electrode design and manufacturing process.

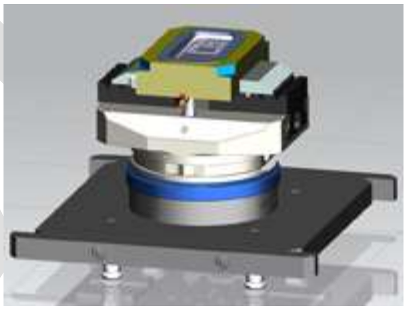

Fig. 18 NX for Jig and Fixture Design[10]

Because jig and fixture designs are fully associative to the part model, you can quickly and accurately update fixtures based on part model changes. You can easily position and mate fixture components with the NX assembly capabilities, and then automatically create drawings and documentation for the fixture and its components. NX also allows you to simulate the kinematics of fixtures, such as opened and closed positions, and check for strength and distortion.

Michael Stampfer[2] presented a paper which deals with the problem of setup and fixture planning for the machining of box-shaped parts on the horizontal machining centers. The setup and fixture planning shown in fig. 2. The central topic of this research is the automation of the conceptual design of fixtures shown in fig. 3. This topic is deal with the setup planning.

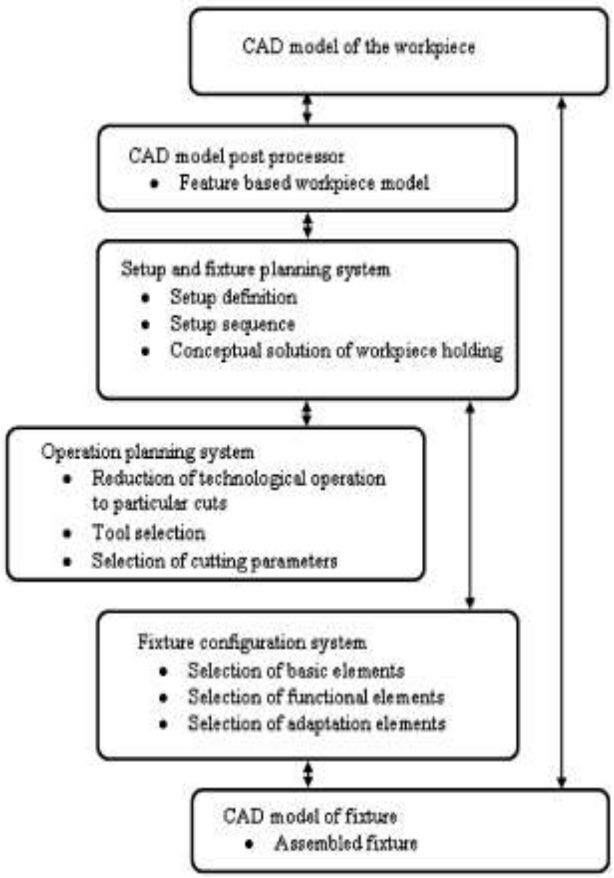

Fig. 19 Integrated process planning and fixture planning system[2].

The integrated handling of tasks of setup and fixture planning and the finding of solution in an integrated system is , the main aim of the author. Based on the workpiece model, the setup sequence, the conceptual solution of fixture for each setup determined automatically by the developed system.

1.Fixturing Functional Requirements

From a layout point of view, fixtures have six basic functional requirements **:**

(1) Stable resting, (2) accurate localization. (3) support reinforcement, (4) stable clamping, (5) foreclosure(or total restraint) and (6) quality performance.

The functions have strong precedence conditions. The first five functions are required at the fixturing stage, and sequentially. When a workpiece is placed into a fixture, it must first assume a stable resting against the gravity. Then, the locators should provide accurate localization. Next, supports are moved in place, and finally clamps are activated for the part immobilization (force-closure). The part location must be maintained in the process of instantiating clamps without workpiece lift-off. The performance of the fixture is ultimately defined as workpiece geometric error during the manufacturing stage. The geometric error is mainly determined by the fixture localization accuracy and the workpiece static and elastic deformation during manufacturing. There are additional constraints to be satisfied such as interference-free and easy loading and unloading.

2. Design Consideration in Fixtures

a. The main frame of fixture must be strong enough so that deflection of the fixture is as minimum as possible. This deflection of fixture is caused because of forces of cutting, clamping of the workpiece or clamping to the machine table. The main frame of the fixture should have the mass to prevent vibration and chatter.

b. Frames may be built from simple sections so that frames may be fastened with screws or welded whenever necessary. Those parts of the frame that remain permanently with the fixture may be welded. Those parts that need frequent changing may be held with the screws. In the situation, where the body of fixture has complex shape, it may be cast from good grade of cast iron.

c. Clamping should be fast enough and require least amount of effort.

d. Clamps should be arranged so that they are readily available and may be easily removed.

e. Clamps should be supported with springs so that clamps are held against the bolt head wherever possible.

f. If the clamp is to swing off the work, it should be permitted to swing as far as it is necessary for removal of the workpiece.

g. All locator’s clamps should be easily visible to the operator and easily accessible for cleaning, positioning or tightening.

h. Provision should be made for easy disposal of chip so that storage of chips doesn’t interfere with the operation and that their removal during the operation doesn’t interfere with the cutting process.

i. All clamps and support points that need to be adjusted with a wrench should be of same size. All clamps and adjustable support points should be capable of being operated from the fronts of the fixture.

j. Work piece should be stable when it is placed in fixture. If the work piece is rough, three fixed support points should be used. If work piece is smooth, more than three fixed support points may be used. Support point should be placed as farthest as possible from each other.

k. The three support points should circumscribe the centre of gravity of the workpiece.

l. The surface area of contact of support should be as small as possible without causing damage to the workpiece. This damage is due to the clamping or work forces.

The importance of fixture design automation is emphasized by Djordje Vukelic [3]. General structure of the automated design system shown in fig. 20 with a highlight on the fixture design systems and their main characteristics.

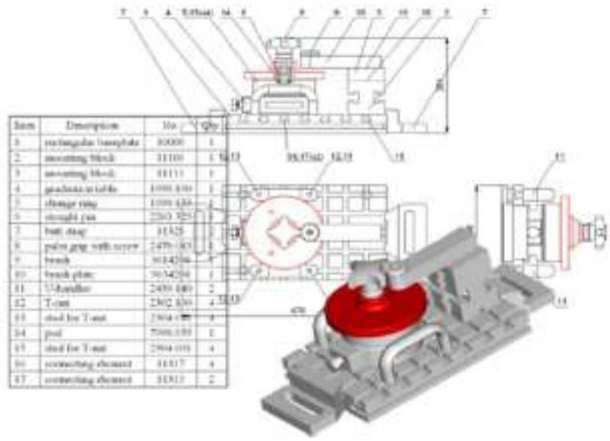

Fig. 20 Layout of working [3].

It also shows a structure and a part of output results of the automated modular fixture design system. The expert systems have been mostly used for the generation of partial fixture solutions, i.e., for the selection of locating and clamping elements.

Shrikant [8] discussed various design and analysis methods in the context of to improve the life of fixture, different fixture geometries are compared experimentally and are selected. The proposed eccentric shaft fixture will fulfilled researcher Production target and enhanced the efficiency, fixture reduces operation time and increases productivity, high quality of operation,

Weifang Chen [4] developed a multi-objective model was established to increase the distributing uniformity of deformation and to reduce the degree of deformation. The deformation is analyzed by optimizing the finite element method. To solve the optimization model a genetic algorithm was developed. A satisfactory result was obtained by illustrating an example, which is superior than the experiential one.

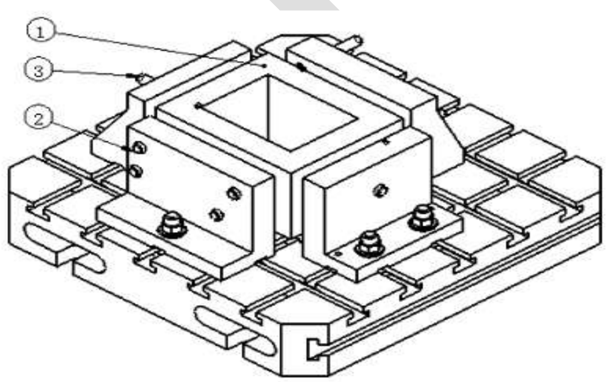

Fig. 21 A real case fixture configuration [4]

The multiobjective model can reduce the machining deformation effectively and improve the distribution condition. This paper presented a fixture layout design shown in fig. 21 and clamping force optimization procedure based on the GA and FEM. The optimization procedure is multi-objective: minimizing the maximum deformation of the machined surfaces and maximizing the uniformity of the deformation. The ANSYS software package has been used for FEM calculation of fitness values. The combination of GA and FEM is proven to be a powerful approach for fixture design optimization problems. In this study, both friction effects and chip removal effects are considered. a database is established to reduce the computation time, for the chromosomes and fitness values, and the meshed workpiece FEA model is repeatedly used in the optimization process.

Fig. 22 shows the existing CAD model of fixture which is used for machining of hydraulic lift housing. In this fixture clamping is done manually so there is extra time loss for loading and unloading operation. To avoid this problem there is necessity to develop new design to improve the productivity.

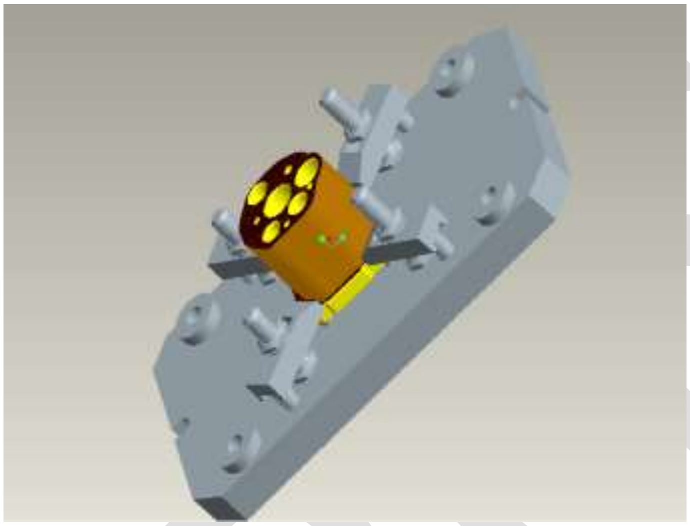

Fig. 22 CAD model of complete fixture assembly

- **Type of machine**

-Vertical machining centre.

- **Operations**

-Drilling.

-Reaming.

-Champer.

Machining parameter for drilling

- Cutter diameter 18 mm
- Number of flute 4
- Spindle speed 500 rpm
- Feed 0.15 mm/rev
- Radial depth 18 mm
- Projection length 90 mm

Machining parameters for reaming

- Cutter diameter 26 mm
- Number of flute 4
- Spindle speed 120 rpm
- Feed 0.25 mm/rev
- Radial depth 26 mm
- Projection length 90 mm

3.TYPES OF FIXTURE AND ITS INDUSTRIAL APPLICATIONS

Vise Fixture It is easy to clamp workpiece with regular shape and parallel sides in a vise. However, workpieces with round or irregular shapes are very difficult to clamp properly. Hence, special jaws are created to hold workpieces with irregular shape properly and at the same time, it also avoid damage to the important surfaces. Stop pin is used to prevent bending of the workpiece by the application of clamping force. guide pins are used to secure alignment. When it is necessary to hold the workpiece firmly in all the direction.

Fig. 23 Vise Fixture[11]

Facing Fixture Milling machines are extensively used for facing seating and mating flat surfaces. Milling is often the first operation on the workpiece. The workpiece is positioned by three adjustable spherical ended pads 'A'. These pads are adjusted to suit the variation in the size of workpiece and lock in the position by check nuts. Two self adjusting supports 'A' are pushed upward by light spring. These springs are used to make sure that the support 'A' is positively in contact with the workpiece. Clamping screw is used to lock support 'B'. On tightening the edge clamp, the workpiece is pushed against the fixed jaw. This jaw is keyed in the fixture body to provide solid support to workpiece against the heavy thrust developed in the operation. The cutter should be fed to the workpiece in such a manner that the milling thrust should be directed towards the solid support of fixed jaws. The setting can be set in the path of cutter to set it before starting of facing operation. Four clamping slots are provided to take care of the heavy forces developed during the operation.

Boring Fixture According to the type of boring operation, boring fixture are used. Boring Fixture may have characteristics of a drill jig or a mill fixture. The workpiece always has an existing hole which is enlarged by the boring operation. It may be final or may be preliminary to grinding and other sizing operation.

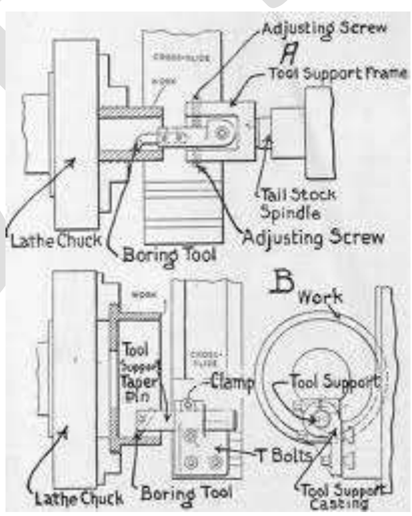

Fig. 24 Boring Fixture[11]

Face Plate Fixture It can be used conveniently for machining of simple and small components. Addition of locators and clamps on face plate help in quick location and clamping of workpiece. Face plate fixture is useful for facing number of workpieces simultaneously on the lathe.

Turning Fixture These are generally special face plates. Their swing should be lesser than the swing of the machine. These are used for quick location and clamping. Typical turning fixture . The workpiece rests on angle plate and its boss is centralized with machine axis by sliding *v*-block which can be operated with knurled screw. The overhang of turning fixtures should be minimum bare necessary for the operation. Fixture should be balanced with workpiece in position.

Fig. 25 Turning Fixture[11]

The clamping arrangement should be capable of withstanding the various forces developed during operation.

a. Cutting force tangential to cutting circle.

b. Axial force and radial force due to feed of tool.

c. Bending forces due to pressure of tool on workpiece.

Back Plate for Turning Fixture It consists of workpiece locating and clamping elements. These fixtures are generally used for facing turning and boring operation. The workpiece should be located correctly with respect to rotating machine spindle for all these operations.

Grinding Fixture The standard magnetic tables are used to rest workpiece such that resting surface will be parallel to the surface to be ground. However, for light workpiece with lesser resting area, the resting area tends to tilt and fly off the magnetic table due to high speed of grinding wheel and due to high feed, also. Hence, it is necessary to provide additional support by nesting the workpiece. This can be done by placing the solid plates around the workpiece. The nest plates are held firmly by the magnetic force of table with more weight and more resting area. The nest plates surround the workpiece from outside and arrest its movement in the horizontal plane. Thus, this arrangement will help in preventing it from flying off and tilting due to high speed and feed in grinding operation.

Fig. 26 Grinding Fixture[11]

VI.HYDRAULIC CLAMPING

Hydraulic clamping is actuated by cylinders. Clamping fixtures mainly consist of clamping nut which is attached to cylinder ram. A Pressurized fluid pulls ram and clamps against workpiece. Unclamping, port connected to unpressurized discharge line. For clamping and unclamping we use three way direction control valve, lever and pedal.

MULTIPLE CLAMPING

Single direction control valve can actuate number of clamps through number of cylinders to pressure or discharge lines. Clamping pressure is varied by regulating pressure of fluid.

High pressure – heavy roughing cut

Low pressure – light finish cut.

A risk of sudden pressure drop in event of power failure can be countered by provision of non return valve in pressure supply line.

AIR ASSISTED HYDRAYLIC WORK HOLDING

It is divided into three groups of components. First group of component, the shop air system (6-12bar) provides power, in the form of pneumatic pressure. Shop air(pressurized air) system consists of air inlet, filter/regulator/lubricator device, the safety valve /release valve. The second group of component is hydraulic booster consists of booster, check valve, and manifold. The final group is clamping system- hold, position, and support work piece.

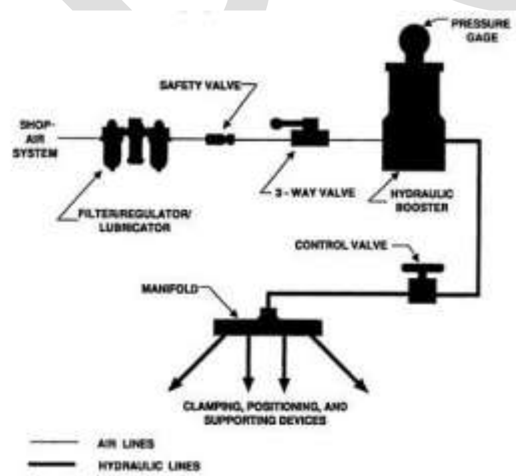

Fig. 23 Hydraulic workholding system.

Shop air is just used for boosting .In addition electric booster and hydraulic pump are used to air- operated booster system. Hydraulic pump is used for larger applications. Accumulator is installed between clamps and power source which maintain the necessary pressure when power is disconnected

VII. Conclusion

The efficiency and reliability of the fixture design has enhanced by the system and the result of the fixture design has made more reasonable. To reduce cycle time required for loading and unloading of part, this approach is useful. If modern CAE, CAD are used in designing the systems then significant improvement can be assured. To fulfill the multi-functional and high performance fixturing requirements optimum design approach can be used to provide comprehensive analyses and determine an overall optimal design. Fixture layout and dynamic clamping forces optimization method based on optimal fixture layout could minimize the deformation and uniform the deformation most effectively .The proposed fixture will fulfilled researcher production target and enhanced the efficiency, Hydraulic fixture reduces operation time and increases productivity, high quality of operation, reduce accidents.

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